Chapter 7: Additional Improvement Opportunities

CHAPTER CONTENTS

CHAPTER OVERVIEW

This chapter discusses some techniques beyond alternative ink systems and printing processes that flexographic printers can use to prevent pollution, reduce chemical consumption, and minimize waste. This chapter includes sections on pollution prevention, recycling and resource recovery, and control options.

Pollution prevention, also known as source reduction, involves reducing or eliminating environmental discharges at their source (that is, before they are generated). Pollution prevention requires taking active steps to implement changes in workplace practices, technology, and materials, such as the type of ink used. By reducing the amount of waste produced in the first place, disposal and compliance issues are minimized. Each step in the printing process offers opportunities for pollution prevention. Flexographic printers may be able to receive several benefits from following pollution prevention practices, including cost savings, improved productivity, better product quality, reduced health risks to workers, reduced pressures of regulatory compliance, and of course reduced environmental impacts. Pollution prevention is discussed in Section 7.1.

Recycling, which is also sometimes called resource recovery, is the focus of Section 7.2. Although recycling is not pollution prevention, since it does not reduce the amount of pollution being generated, it too has benefits for flexographers, including reductions in the need for new materials and for solid waste disposal. Thus, recycling can help printers reduce the costs of doing business. Silver, solvents, and many solid wastes can all be recycled.

In addition, several pollution control options are possible for both liquid and gaseous forms of flexographic ink chemicals. Section 7.3 discusses several common control options. These technologies can be very successful in reducing waste and emissions in the flexographic industry. Control options that are discussed in Section 7.3 include oxidizers, adsorption systems, permanent total enclosures (capture devices that work with control options but do not destroy harmful emissions by themselves), and ink splitters. Control options, however, often require a major capital investment, and must receive regular maintenance to function efficiently. Also, even control options that destroy virtually all harmful emissions have no effect on the types and amounts of chemicals being purchased and used by flexographic printers. That is, they do not prevent pollution from being generated.

7.1 POLLUTION PREVENTION OPPORTUNITIES

Pollution prevention, also known as source reduction, reduces or eliminates environmental discharges at their source — that is, by avoiding their creation. Pollution prevention can be achieved by changing workplace practices, substituting safer alternatives for harmful chemicals, and modifying equipment to reduce waste. In addition to reduced environmental impacts, pollution prevention may yield the following benefits:

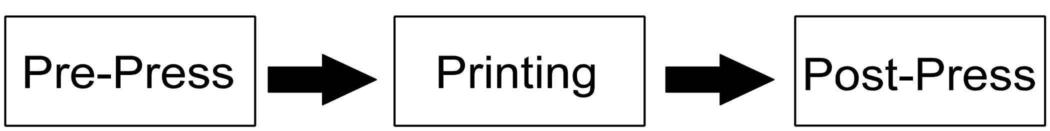
- cost savings
- improved productivity and product quality
- minimized risks to worker health
- reduced pressures of regulatory compliance

A strategy to prevent pollution should be customized to fit each printer's objectives and production process. The first step is to construct a process flow diagram that identifies each stage of the production process. The next step is to consider the inputs and outputs of each process stage. Once the inputs and outputs are identified, waste streams can be prioritized, and the source of those waste streams can be targeted. Pollution prevention options that target these inputs can then be implemented to reduce or eliminate the corresponding waste stream.

Pollution prevention requires commitment from both management and employees. While management action is required for process changes, employees — who are closest to the process — often are best placed to identify pollution prevention alternatives. Pollution prevention involves taking a proactive stance and frequently reviewing the production processes to find new and better ways of doing business. Figure 7.1 lists the specific process steps in the three major stages of the flexographic printing process where pollution prevention opportunities exist.

Table 7.1 expands upon Figure 7.1 by identifying and describing specific pollution prevention opportunities. Each of the major stages of the printing process provides many opportunities to increase efficiency and potentially save money while improving and maintaining performance standards. Facility-wide opportunities to practice pollution prevention are included at the end of the table. Also, two case studies and a video that further describe pollution prevention activities in the flexography industry are available from the U.S. EPA. Complete ordering information is provided at the end of this chapter.

Figure 7.1 Traditional Process Steps in Flexographic Printing



1. Artwork and Product Design	5. Makeready	8. Laminating and Coating
2. Negatives and Color Proofs	6. Printing	9. Converting
3. Platemaking	7. Cleaning	
4. Mounting and Proofing		

Decision-makers throughout the flexo industry also have many other opportunities to encourage environmental improvements and cleaner, more "sustainable" operations. Pollution prevention involves reducing or eliminating environmental discharges *before they are generated*. Pollution prevention requires taking active steps to implement changes in workplace practices, technology, and materials, such as the type of ink used. By reducing the amount of waste produced in the first place, disposal and compliance issues are minimized. Each step in the printing process offers opportunities for pollution prevention. Flexographic printers may be able to obtain a number of benefits from following pollution prevention practices, including cost savings, improved productivity, better product quality, reduced health risks to workers, reduced pressures of regulatory compliance, and of course reduced environmental impacts. Control options are less desirable than pollution prevention because they manage pollutants that have already been created. Control technology also can break down, and require expensive capital and maintenance costs.

Some opportunities for pollution prevention in flexo printing follow.

Pre-Press

- Use Computers for Proofs and Plates: By using computers to generate all proofs and plates, printers can skip photographic development and eliminate the use of darkroom chemicals.
- Switch from Rubber to Photopolymer Plates: Use of traditional nitric acid baths to etch designs into metal plates may generate wastewater that is low in pH and high in metal content, requiring regulation under the Clean Water Act. Photopolymer plates eliminate this waste stream as well as the metal engravings and wastes generated from the production of conventional molded rubber plates.

Printing

- Cover Volatile Materials: By keeping all cans, drums, and open ink fountains covered, printers can reduce odors and worker health risks by minimizing fugitive VOC emissions.
- Install Enclosed Doctor Blade Chambers: Enclosed doctor blade chambers reduce ink evaporation, which results in better control of ink usage, more consistent color, and improved performance of the inks on press. Making this change to an older press may greatly reduce ink evaporation, thus minimizing worker exposure to hazardous chemicals.
- Use Higher Linecount Anilox Rolls: This enables printers to apply smaller ink droplets closer together, to achieve much finer ink distribution, easier drying, and potentially faster press speeds.
- Rework Press Return Ink: Reworking press return ink can increase efficiency, reduce ink purchases, and reduce hazardous waste if contamination issues can be addressed. Ink can be reworked by blending press return ink with virgin ink or other press return inks.
- Use Computerized Ink Blending: Software and specialized equipment help printers blend ink, reduce surplus ink, and reuse press return ink.
- Print with Four-Color Process: The limited number of inks in four-color process printing can minimize the amount of mixed colored inks used and eliminate residues of unusual colors at the end of each job. With chambered doctor blade systems, the increased use of process printing to produce a broad spectrum of colors has become more easily attainable.

- Co-Extrude Colored Film: Films can be co-extruded to have panels of color in a clear field, which eliminates the need for heavy coverage with colored ink.
- Run Light Colors First: By running lighter jobs before darker jobs, printers can reduce the number of clean-ups.
- Standardize Repeat Print Jobs: Make-ready times and wate materials can be greatly reduced if the press operators knows the anilox roll linecount and cell volume, the sequence of colors, applied, ink parameters such as pH and viscosity, and other set-up information.
- Standardize Anilox Roll Inventory: This saves time during makeready and reduces waste.
- Use Multi-Stage Cleaning: Solvent use can be reduced by using a multi-stage cleaning procedure for the printing decks. This procedure reduces solvent use by reusing solvents that are otherwise discarded. Pre-used solvent is used in the first stage to remove the majority of the ink. In the second stage, a cleaner but still pre-used solvent is employed to remove more ink. In the third stage, clean solvent removes any remaining ink.
- Install Automatic On-Press Cleaning: When paired with solvent recovery, on-press cleaning systems use much less cleaning solution than hand cleaning, while also having a very short cycle time.
- Clean Anilox Rolls Promptly: Prompt attention will prevent the inks from setting, thereby reducing the need for harsh chemicals. Clean rolls also produce more predictable ink densities, potentially reducing on-press waste and improving quality.
- Use Alternative Methods to Clean Anilox Rolls: Printers can choose among many alternatives for cleaning anilox rolls to reduce or eliminate the need for traditional cleaning solvents. These alternatives use sonic cleaning, dry ice, lasers, polyethylene beads, and sodium bicarbonate.
- Recirculate warm press air: Both solvent-and water-based printers can significantly reduce their energy requirements by recirculating warm air from dryers.

Throughout the Printing Process

- Use Safer Chemicals: Switching to inks, cleaning agents, and adhesives that contain a lower percentage of VOCs and fewer HAPs may reduce risks to worker health and the environment.
- Segregate Hazardous Waste: Segregating hazardous wastes allows disposal of pure instead of mixed wastes. Because pure wastes are much easier to treat than mixed ones, they are not only less expensive to dispose of, but also require less energy.
- Return Containers: Using returnable containers prevents unnecessary waste generation and results in additional cost savings.
- Track Inventory: Tracking chemical purchases and disposal can help to maintain a minimum inventory on the shelf, thus reducing the amount of materials wasted. For example, hazardous waste can be minimized by labeling inks with the date and having a “first-in, first-out” rule, i.e., rotating the inks so that the oldest inks are used first. This avoids disposing of expired ink as hazardous waste. Tracking systems using bar codes take inventory control to an even higher level.

- Make a Management Commitment: Management should establish, communicate, and demonstrate their commitment to the concept of pollution prevention, to encourage company-wide source reduction in everyday practice. Management can assemble pollution prevention teams of employees, incorporate pollution prevention into job responsibilities, and provide incentives for employees to prevent pollution.
- Train Employees: Pollution prevention training for company personnel may facilitate process changes by educating workers on the need for such change. Training also helps to encourage general source reduction and stimulate pollution prevention ideas by personnel.
- Monitor Employee Practices: Periodic monitoring helps ensure that source reduction practices are followed.
- Seek Out and Encourage Employee Initiatives: Supporting, encouraging, and actively acknowledging pollution prevention initiatives by company personnel can stimulate innovative ideas for source reduction. This may be especially beneficial because employees who are closest to the process are often in the best position to recommend change.
- Develop an Environmental Management System (EMS): An EMS is a set of management tools and principles designed to guide a company to integrate environmental concerns into its daily business practices.

7.2 RECYCLING AND RESOURCE RECOVERY

Recycling (also known as resource recovery) helps reduce the need for virgin (never previously used) materials and lowers demand for solid waste disposal. Municipal and local governments often sponsor recycling programs and waste exchanges. By incorporating recycling, flexographic printers may be able to avoid or reduce the costs of handling, permitting, shipping, and disposing of wastes, as well as the regulatory and legal liabilities and costs.

Silver Recovery

Silver in wastewater is toxic, and its disposal is regulated locally by publicly owned treatment works (POTWs). Silver is used for film development in pre-press operations. Printers can recover silver from the wastewater coming out of their imaging operations. There are three main methods for recovering silver: metallic replacement, electrolytic silver recovery, and ion exchange.

Metallic Replacement
Wastewater is passed through one or more steel wool filters in which silver is chemically replaced by iron. The silver is collected in the form of sludge, which is then treated off-site to extract the usable metal. This method is used in many pre-press and print shops, and is relatively inexpensive.

Electrolytic Silver Recovery
An electric current passes between two electrodes in silver-laden wastewater, plating the silver on the cathode in a virtually pure form. The silver is easily removed from the cathode for reuse. This system is more expensive to purchase and maintain than the metallic replacement system. This is often used in conjunction with a steel wool filter.

Ion Exchange

Ion exchange can remove an extremely high percentage of silver, but is only suitable for dilute solutions. In addition, this method requires a greater capital investment and handling time than the other two methods.

Solvent Recovery

Flexographic printers who use solvent-based inks and cleaners can recover much of the solvent for reuse in the facility. A solvent recovery system captures VOC emissions, and uses a separation/distillation unit to separate and collect the solvent. Recycled solvent sometimes needs further treatment before it can be reused. Recycled solvent is often used in cleaning operations and saves the printer the cost of buying virgin solvent.

Solid Waste Recycling

Flexographic printing operations generate solid waste that must be disposed of in landfills or incinerated. Printers have found that recycling solid waste can reduce shipping and disposal costs, and that items can be reused in the shop or by the supplier. Flexographic printers can reduce solid waste in any of the following ways:

- Require suppliers to take back all containers and packaging.
- Work with local government to establish recycling practices.
- Choose materials (e.g., substrates) that can be recycled.
- Minimize coatings that hinder recycling.

Some specific examples of solid waste recycling include the following ideas:

- Bale paper waste, corrugated cartons, and pallet tote boxes for recycling.
- Return cores that are used to wind rolls of films, papers, and paperboard to the supplier for reuse.
- Collect and return shrinkwrap films for recycling. Segregate plastics by type to enable efficient reuse of the materials.
- Clean and reuse cans, bottles, plastic jugs, drums and other containers.
- Recycle photographic chemicals and platemaking chemicals. Negatives and photographic papers can be treated to recover silver.
- Pelletize unusable rubber, photopolymer plates, and mixed substrate wastes (e.g., laminations and pressure-sensitive materials) to use as alternative fuel at cement kilns and power generation plants.
- In some states, printers can recycle components of fluorescent lamps, including hazardous wastes like mercury.

7.3 CONTROL OPTIONS

Control technologies minimize the toxicity and volume of flexographic pollutants by destroying them or capturing them for reuse, recycling, or disposal. Specific control option choices need to be based on many considerations, such as regulations, the facility's printing equipment, the ink systems and chemicals that the facility uses, cost and performance needs, and risks to the safety and health of workers and the environment.

Control systems can be costly, must be maintained, and have the potential to fail. Using chemicals that contain or generate pollutants carries risks for workers and the environment, and may present a public relations problem. Disposal of regulated wastes may require a printer to obtain status as a hazardous waste generator. The potential disadvantages of control systems make it important for printers to consider pollution prevention, which can reduce the need for control systems in flexographic facilities.

Sources of Flexographic Ink Pollutants Amenable to Treatment or Control Options

Pollutants that are related to flexographic printing inks and that can be mitigated using treatment or control options fall into several categories:

- Air emissions
- Hazardous liquid wastes, especially solvents
- Non-hazardous liquid wastes, including many waste inks, additives, and colored wash-water

Control Options and Capture Devices for Air Releases

All solvent-based and some water-based flexographic inks contain significant amounts of volatile organic compounds (VOCs). Some flexographic inks also contain one or more hazardous air pollutants (HAPs), as defined by the Clean Air Act.[a]

Several types of control options[b] for handling air emissions related to working with flexographic inks are currently available and will be discussed in this section. In addition, a capture device such as a permanent total enclosure (PTE) may be installed in conjunction with control options and are part of the overall control efficiency. Three types of devices associated with emission control are discussed in this section.

- permanent total enclosures
- oxidizers (thermal, catalytic, and regenerative)
- adsorption systems

[a] Smaller amounts of ozone also may be generated by the use of corona treaters and UV lamps, but ozone can be easily destroyed at the source by relatively inexpensive devices supplied (often with the primary equipment) by the manufacturer/distributor. Ozone that is destroyed immediately upon creation does not present an environmental concern.

[b] Biofiltration, also known as bioremediation, is a currently experimental method of destroying VOCs. This technology uses microbes that eat and digest VOCs, breaking them down into more environmentally benign chemicals. Biofiltration may hold promise for flexographic printing in the future, if the technology can be improved to enable reliable destruction of virtually all VOCs.

Capture Devices

A permanent total enclosure (PTE) is a structure that captures all fugitive emissions from a source (e.g., a single press or an entire press room) and sends them to a destruction/recovery device. A PTE alone only captures emissions; it neither destroys them nor reduces their use, but is part of the overall control efficiency or capture efficiency. Because of this, a PTE is used in combination with an oxidizer, adsorption system, or biofiltration device, which separates or destroys VOCs.

Regulations controlling air emissions are expected to continue to be strict across the country for the foreseeable future. A PTE is currently the only capture tool that effectively captures 100% of fugitive emissions.[1] Because a PTE is a permanent structure, only one demonstration inspection is required for a new PTE. Thereafter, as long as the facility continues to use the PTE in the same way without significant structural modifications, additional air inspections are not necessary.

A specific method and criteria have been set forth by EPA for constructing a PTE that will pass inspection. Depending upon the scope and size of the work that is needed, construction of a PTE can be fairly modest, or it can involve a substantial capital investment ranging up to tens of thousands of dollars.[2] The installation of a PTE also may involve compliance with local fire codes that designate the enclosed area as a hazardous area (H occupancy) and require steps or devices such as emergency ventilation, fire containment (fire walls and doors), an emergency egress route, and spill containment.[3] However, since most of the cost relates to capital and construction rather than operation and maintenance, in the long run some printers may find a PTE to be quite economical.

A well-designed PTE captures all fugitive emissions and eliminates fugitive air emissions to the local community. In addition, some printers may be able to benefit economically from PTEs, as more areas introduce the use of transfer credits for air emissions. Because a PTE guarantees 100% capture efficiency, printers in areas that require a lower percentage of capture efficiency may be allowed to sell or trade their credits.[4] For all these reasons, PTEs are expected to continue to be an important method of controlling fugitive air emissions for flexographic printers.

Oxidizers

Oxidizers burn air that contains VOCs and sometimes other pollutants generated in flexography. An oxidizer breaks down VOCs into water, carbon dioxide, and other gases. Oxidation works by mixing the emissions from the press exhaust with oxygen and heat. There are several types of oxidizers, including catalytic, thermal, thermal recuperative, and regenerative oxidizers. All types of oxidizers have the potential to achieve virtually complete destruction of VOCs. Straight thermal oxidizers require high operating temperatures (typically at least 1600˚F), whereas thermal recuperative oxidizers recover much of the waste heat from exhaust gases and thus are more economical. Catalytic oxidizers can operate at lower temperatures than thermal types (up to about 1250˚F) and use less fuel. Regenerative oxidizers may be either thermal or catalytic, as defined above.[5]

Catalytic oxidizers are more common in the flexographic printing industry than are thermal oxidizers; however, recent technical advances in thermal systems may make these appropriate for some printers.[6] Because of their lower operating temperatures, catalytic oxidizers create a very low percentage of NOx (nitrogen oxide) emissions[c] compared to

[c] Nitrogen oxides are ozone precursors.

thermal oxidizers. However, catalytic oxidizers may not be effective in treating gases from certain silicone ink additives, because silicone masks or poisons the catalyst.[7]

Oxidizers usually involve a significant capital and installation investment, as well as substantial operating expenses. The total capital cost of an oxidizer can range from $150,000 to $400,000 or more, depending upon the size and needs of the facility.[8,9,10,11] Energy consumption considerations for catalytic oxidizers are discussed in Chapter 6.

Adsorption Systems

These devices contain a bed of activated carbon, zeolite (an aluminum-silicate crystal), or polymers. This substance attracts VOCs, which adsorb (concentrate) on the surface of the medium. Adsorption separates but does not destroy VOCs. The air that no longer contains VOCs then can be released, and the VOCs can be reused or recycled. A typical adsorption system alone has the potential to remove 95% or more of VOCs,[6] and is normally used in conjunction with a PTE to ensure virtually complete removal of VOCs.

Carbon adsorption systems work most efficiently in capturing a single solvent or a very dilute stream of VOCs, and they are not necessarily compatible with all inks. Because flexography typically uses a large number of solvents, carbon adsorption was not appropriate for most printers at the time of publication of this CTSA.[6]

The costs of adsorbent systems ranges widely depending on a number of factors, including the type and size of the facility, the type of absorbent system, state regulatory requirements, and permitting issues. Systems can cost from several thousand to several hundred thousand dollars. Also, since an adsorption system is normally used in conjunction with a PTE, that cost must be considered as well. For these reasons, a meaningful cost range for this technology is beyond the scope of this document.[d]

Control Options for Liquid Releases

Flexographic facilities need to pay attention to three characteristics of liquid ink wastes: percentage of solvents, turbidity (discoloration), suspended solids, and hazardous substances.

The maximum solvent content allowed in wastewater is site-specific. For facilities using only water-based inks, if the percentage of petroleum-based solvents is below the level allowed by the facility's municipal wastewater facility (Publicly Owned Treatment Works, or POTW) or permit (if applicable), the liquid waste might not be regulated as hazardous waste. Facilities using only UV inks typically will not have solvent-containing liquid wastes.

For all types of inks, EPA considers discoloration of water to constitute "turbidity," which is a pollutant category. Pigments and other discoloring substances may have to be removed before the water can be discharged to a POTW. Also, ink wastes may have other substances that are regulated as hazardous (e.g., metals) and must be removed before discharge. Please see Chapter 2, Federal Regulations, for more information on chemicals in this CTSA that may be regulated as hazardous wastes.

[d] The U.S. EPA's Office of Air Quality Planning and Standards "EXPOS Control Cost Manual" (5th Ed., February 1996, document EPA 453/B-96-001), provides detailed procedures, data, and equations for sizing and estimating capital and operating costs of thermal regenerative carbon adsorption systems.

Ink splitters are used to separate out the solids in wastewater. The water then can be released to a POTW and the pigment-containing sludge sent to a landfill. The capital cost of an ink splitter can range from several thousand dollars to more than $30,000, which can be offset by lower disposal costs and POTWS fees. The relatively low cost of ink splitters and their benefits in helping printers to comply with water emissions standards can make this technology useful to many flexographers.

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